WHAT'S NEW IN VAPOR INTRUSION….

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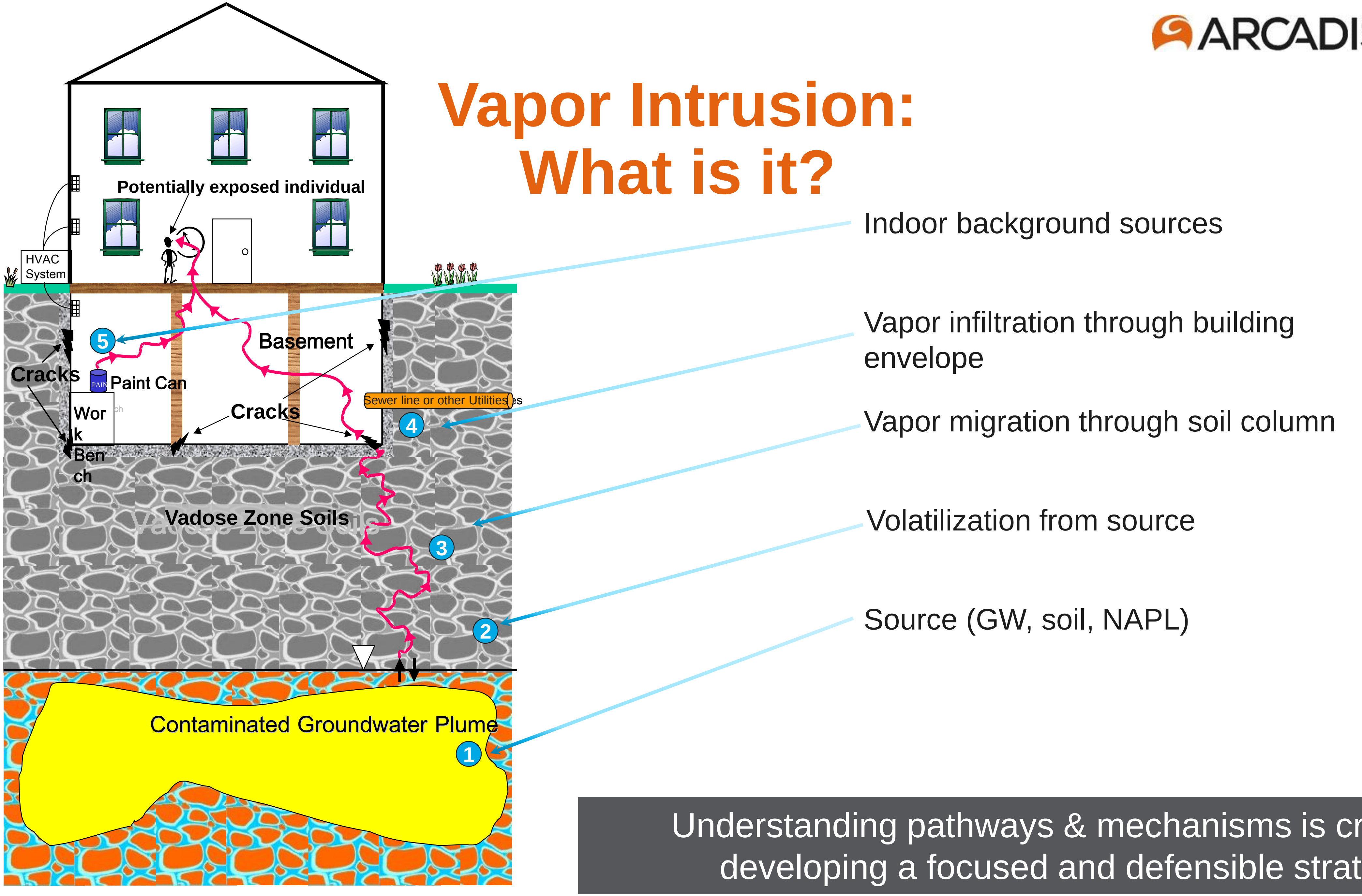
US EPA

Technical Guide for Addressing Petroleum Vapor Intrusion at Leaking Underground Storage Tank Sites

Technical Guidance for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Sources to Indoor Air

Vapor Intrusion: What is it?



Understanding pathways & mechanisms is critical to developing a focused and defensible strategy.

“PVI” Guidance:

Scope of Guidance Document

Which Sites are Included and Which are Not?

Lateral Inclusion Zones and Vertical Separation Distances

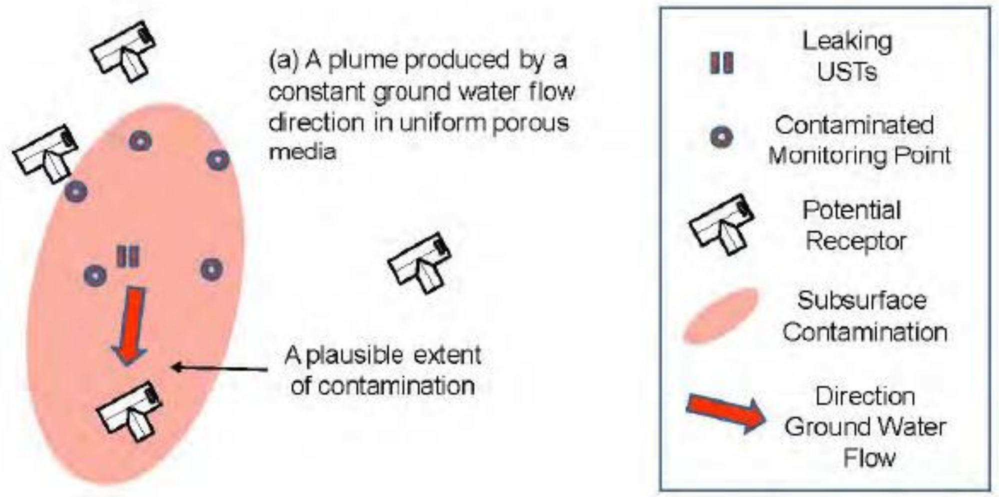
Evaluation of Explosion Risk and Need for Immediate Mitigation

“PVI” Guidance Overview:

- A new document applicable to petroleum hydrocarbon (PHC) and non-PHC fuel additive sites
- The PVI Technical Guide proposes a similar approach to assessing and mitigating PVI as presented for overall VI pathway investigations in the VI Technical Guide with a few key differences
- Does not apply to large petroleum release sites such as oil refineries and pipelines
- The release of the guidance may result in the re-opening of some cases where the potential for PVI was identified but not evaluated.

“PVI” Guidance - Lateral Inclusion Zone:

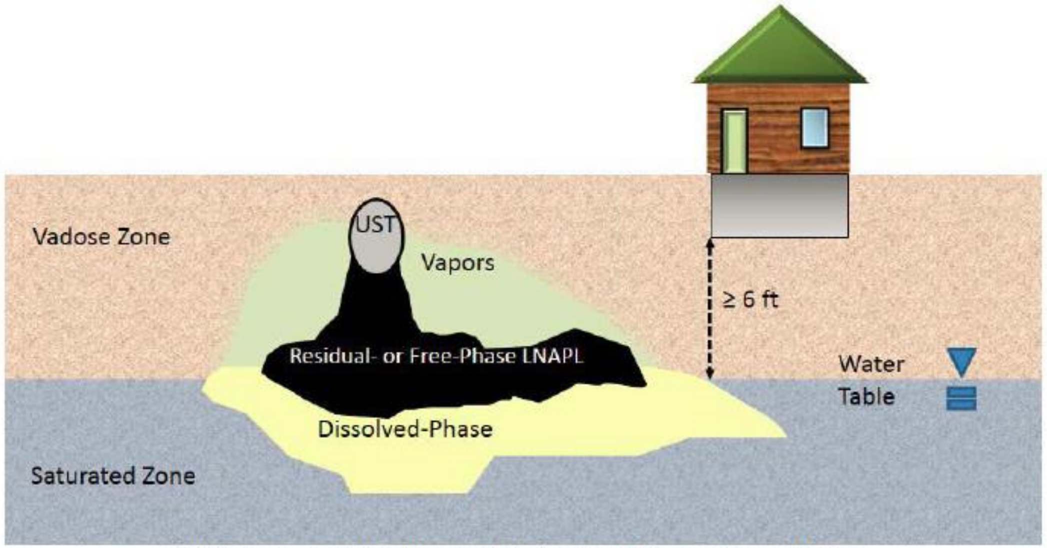
- Used to determine if a structure is at risk from PVI
- Based on the proximity of a structure to the presumed maximum extent of contamination
- In combination, definition of lateral and vertical inclusion zones makes the best use of site characterization data for assessing the risk of PVI to structures at a LUST site



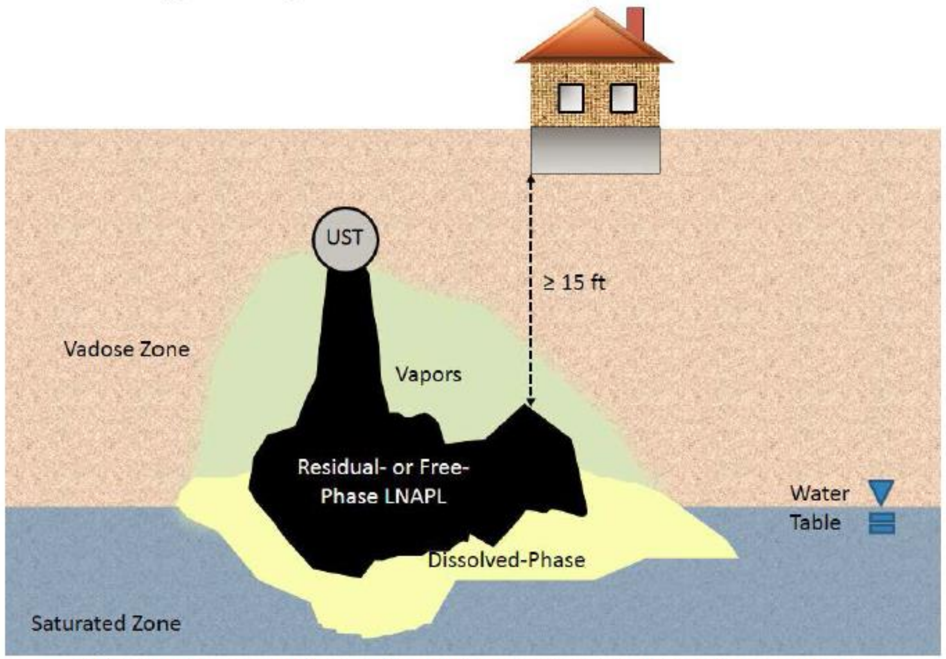
“PVI” Guidance – Vertical Separation Distances:

The vertical separation distance (VSD) is the thickness of clean, biologically active soil between the highest vertical extent of a contaminant source and the lowest point of an overlying building.

For dissolved sources the VSD is the historic high water table elevation; for LNAPL sources this is the top of the smear zone or residual LNAPL in the source area.



(a) Vertical separation distance for dissolved-phase source of PHCs.



(b) Vertical separation distance for LNAPL (residual or mobile phase) source of PHCs.

“PVI” Guidance – Vertical Separation Distances:

Table 3. Recommended Vertical Separation Distance Between Contamination And Building Basement Floor, Foundation, Or Crawlspace Surface.

Media	Benzene	TPH	Vertical Separation Distance (feet)*
Soil (mg/Kg)	≤10	≤ 100 (unweathered gasoline), or ≤ 250 (weathered gasoline, diesel)	6
	>10 (LNAPL)	> 100 (unweathered gasoline) >250 (weathered gasoline, diesel)	15
Groundwater (mg/L)	≤5	≤30	6
	>5 (LNAPL)	>30 (LNAPL)	15

“PVI” Guidance – Explosive Concerns:

PVI may pose both immediate threats to safety (e.g., fire or explosion potential from petroleum vapors) due to the following:

- Volatile chemicals other than PHCs that may be found in petroleum fuels, such as ethers, alcohols, and other fuel additives (e.g., methyl tertiary-butyl ether (MTBE), tertiary-butyl alcohol (TBA), ethylene dibromide (EDB), and 1,2-dichloroethane (1,2DCA))
- Methane, which is generated from anaerobic biodegradation of PHCs and other constituents of petroleum fuels (especially ethanol), and organic matter in soil
- Monitor for explosive conditions using hand held instruments (PID, OVA, LEL detector, etc.)
- Notify first responders in advance of intrusive work
- Use spark proof tools where possible

Vapor Intrusion Technical Guide Topics for Discussion:

- Document History and Evolution
- Evaluating the Potential for Vapor Intrusion
- Thoughts on Vapor Sample Collection
- Spatial and Temporal Variability and Sampling Data Impacts
- Attenuation Factors
- Thoughts on Mathematical Modeling of VI Risks
- Exposure Control Vs. Remediation
- Pre-Emptive Mitigation

Technical Guide – Document History and Evolution:

November 2002, EPA's Office of Solid Waste and Emergency Response (OSWER) issued

- *Draft OSWER Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soil*

2009, EPA's Office of the Inspector General (OIG) recommended that EPA update its 2002 vapor intrusion guidance to reflect the numerous technical advancements that had occurred in the VI field

April 22, 2013, EPA Releases

- *Final Guidance For Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources to Indoor Air* for Public Comment

June, 2015 EPA Releases

- *Final Guidance For Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources to Indoor Air*

Technical Guide – Evaluating Vapor Intrusion Pathways:

The Vapor Intrusion Pathway is Considered Complete when ALL of the Following Conditions are Met:

1. A subsurface source of vapor-forming chemicals is present (e.g., in the soil or in groundwater) underneath or near the building(s)
2. Vapors form and have a route along which to migrate (be transported) toward the building
3. The building(s) is(are) susceptible to soil gas entry, which means openings exist for the vapors to enter the building and driving ‘forces’ (e.g., air pressure differences between the building and the subsurface environment) exist to draw the vapors from the subsurface through the openings into the building(s)
4. One or more vapor-forming chemicals comprising the subsurface vapor source(s) is(are) present in the indoor environment, and;
5. The building is occupied by one or more individuals when the vapor-forming chemical is present indoors.

If one (or more) of the five foregoing conditions is currently absent and is reasonably expected to be absent in the future, the vapor intrusion pathway is referred to as “**incomplete.**”

Technical Guide – Evaluating the Potential for Vapor Intrusion:

Two Step Process – Preliminary Analysis and Detailed Evaluation

Preliminary Evaluation

- History and descriptions of the types of operations and activities that occurred on or near the site and nearby properties
- Information or records about the types of chemicals that may have been used or disposed of at the site
- Information about the site and nearby properties, such as the occurrence of odors, reports of dumping liquids, observations of unreported waste disposal practices, etc.
- Adverse physiological effects reported by building occupants (e.g., dizziness, nausea, vomiting, confusion)
- Evidence of subsurface intrusion of groundwater (e.g., wet basements) reported by building owners or occupants

Detailed Evaluation:

- Develop Risk Based Screening Levels using and VISL Calculator and Conceptual Site Model

Technical Guide – Evaluating the Potential for Vapor Intrusion:

Vapor Intrusion Screening Level (VISL) Calculator

"The primary purpose of the VISL calculator is to assist Superfund site managers and risk assessors in determining, based on an initial comparison of site data against the VISLs: whether chemicals found in groundwater or soil gas can pose a significant risk through vapor intrusion; and, if so, whether a site-specific vapor intrusion investigation is warranted." - USEPA

- **Excel spreadsheet**
- **List of volatile and toxic chemicals**
- **Medium-specific, risk-based target concentrations**
  - indoor air
  - sub-slab/"near-source" soil gas
  - groundwater
- **Derive risk/hazard from media concentrations**
- **C/I and residential scenarios**
- **Frequent toxicity data updates**

Technical Guide – Thoughts on Vapor Sample Collection

Sample Soil Gas Before Indoor Air?

Potential Advantage: Less Disruption to Building Occupants, however;

- *EPA recommends that soil gas samples be taken as close to the areas of interest as possible and preferably from directly beneath the building structure. - USEPA, 2015*
- *Exterior soil gas samples cannot generally be expected to accurately estimate sub-slab or indoor air concentrations. - USEPA, 2015*

Vapor Sample Collection Strategy Should Include:

- Indoor Air Sampling
- Sub-slab Sampling
- Outside Ambient Sampling
- Multiple Sampling Events to Evaluate Spatial and Temporal Variations

Record Weather Conditions (Temperature, Barometric Pressure, Wind Speed and Direction)

Technical Guide – More Thoughts on Vapor Sample Collection

Sub-slab sampling

- Typically 3 sub-slab samples at buildings < 1,500 sq. ft.
- Include central locations
- Record Pressure Differential Across Slab

Indoor Air

- Building survey to Identify Potential Sources Not Related to Vapor intrusion
- Paired Sub-Slab and Ambient Sample Locations
  - Generally limit chemical analyses to those vapor-forming chemicals known or reasonably expected to be present in the subsurface environment

Technical Guide – Air Sampling and Spatial and Temporal Variability

“Field observations and measurements demonstrate that indoor air concentrations can exhibit significant temporal variation within a day and between days and seasons in an individual residential building (EPA 2012a; Holton et al. 2013ab)”

“Concentrations of vapor-forming chemicals in ambient air may exhibit temporal variation over several time scales (e.g., daily, seasonal, longer term) and spatial differences across urban, suburban, and rural land use areas, reflecting differences in emission sources and rates and environmental factors that transport, disperse, and remove these pollutants (Jia et al. 2012 and citations therein)

Concentrations of vapor-forming chemicals arising in indoor air in residential buildings due to indoor sources have been observed to depend upon season and other factors. Available studies suggest complex (e.g., patchy) spatial patterns in exposure concentration, which has led some researchers to refer to “microplumes” in the indoor air environment (McBride et al., 1999 and citations therein).

Recommendation: Multiple Indoor Air Samples Over Time!

Technical Guide – Common Sources of Spatial and Temporal Variability that Impact Sampling Data

Depth to groundwater

Heterogeneities in the subsurface materials

Weather conditions

Building operations

Building construction and age

Interior compartmentalization

Heat Producing Equipment (advection)

Technical Guide – Attenuation Factors

Vapor attenuation refers to the reduction in volatile chemical concentrations that occurs during vapor migration in the subsurface, coupled with the dilution that can occur when the vapors enter a building and mix with indoor air (Johnson and Ettinger 1991).

TABLE 6-1 RECOMMENDED VAPOR ATTENUATION FACTORS FOR RISK-BASED SCREENING OF THE VAPOR INTRUSION PATHWAY[184]

Sampling Medium	Medium-specific Attenuation Factor for Residential Buildings
Groundwater, generic value, except for shallow water tables (less than five feet below foundation) or presence of preferential vapor migration routes in vadose zone soils	1E-03 (0.001)
Groundwater, specific value for fine-grained vadose zone soils, when laterally extensive layers are present [185]	5E-04 (0.0005)
Sub-slab soil gas, generic value	3E-02 (0.03)
"Near-source" exterior soil gas, generic value except for sources in the vadose zone (less than five feet below foundation) or presence of routes for preferential vapor migration in vadose zone soils	3E-02 (0.03)
Crawl space air, generic value	1E-00 (1.0)

Technical Guide – Modeling Role in Vapor Intrusion

In the Past…

Models have been used to predict vapor intrusion impacts to indoor air using a multitude of input parameters (i.e., Building ventilation rate, volumetric flow rate of soil gas entering the building, soil vapor permeability, floor-wall seam perimeter, soil dry bulk density at the source of contamination, etc.).

Current Thinking from 2015 Guidance…

When suitably constructed, documented, and verified, mathematical models can provide an acceptable line of evidence supporting risk management decisions pertaining to vapor intrusion.

Mathematical modeling is most appropriately used in conjunction with other lines of evidence

Unless site-specific parameter values are obtained for input parameters and the mathematical model is calibrated to field data, use of default input parameter values will generate model results that lie at an unknown point within an uncertainty band of the model outcomes

Because the combined effect of parameter uncertainty is large, a one- or two-order of magnitude error might be made unknowingly.

Technical Guide – Managing the Problem

Exposure Control Vs. Remediation

Engineering Controls Not a Substitute for remediating the Subsurface Source:

- *Even when operated for prolonged periods, engineered exposure controls are considered 'interim' remedies for purposes of this Technical Guide, because their implementation does not substitute for remediation of the subsurface source(s) of vapor-forming chemicals. Engineered exposure controls may, nevertheless, become part of a final cleanup plan. – USEPA, 2015*

Short Term Exposure:

- *EPA recommends the noncancer assessment consider the potential for adverse health effects from short-duration inhalation exposures (i.e., acute, short-term, or subchronic exposure durations) – USEPA, 2015*

Prompt Response Scenarios

- Potentially explosive atmospheres
- Potential for short term health effects